Chemical Bonding and Reactions

PS-4 The student will demonstrate an understanding of chemical reactions and the classifications, structures, and properties of chemical compounds.

PS-4.1 Explain the role of bonding in achieving chemical stability.
Taxonomy Level: 2.7-B Understand Conceptual Knowledge

Key Concepts:
Stability: Noble gas configuration
Bond: Ionic bond, Covalent bond
Ion

Previous/Future knowledge: In the 7th grade students recognize that matter is composed of extremely small particles called atoms (7.1); classify matter as element, compound, or mixture on the basis of its composition (7.2); compare the physical properties of metals and nonmetals (7.3); and use the periodic table to identify the basic organization of elements and groups of elements (including metals, nonmetals, and families) (7.2).
In Physical Science students will expand their concepts of atoms and how they bond with other atoms to form compounds. A key concept will be the formation of chemical bonds to make the atoms more stable.

It is essential for students to

- Understand that all of the noble gases are chemically stable. This is the observable fact that is the basis for all theories dealing with bonding.
- Understand that a *noble gas electron configuration* (an outside energy level with 2 or 8 electrons) is chemically *stable* and that all atoms would be more stable if they had these electron configurations. When forming compounds, atoms gain, lose, or share electrons to reach an electron situation equal or similar to one of the noble gases.
  - Helium atoms are stable atoms with **two** electrons in the outside energy level. Some atoms will lose, gain, or share electrons to have two electrons like helium and become chemically stable.
  - Atoms of the other noble gases (neon, argon, krypton and radon) are stable atoms with **eight** electrons in the outside energy level. Some atoms lose, gain or share electrons to have **eight** electrons in the outside energy level like the closest noble gas and become chemically stable.
- Understand that when atoms bond chemically, they do so to become more stable.
  - Having the outside energy level full or "complete" like noble gases is more stable than other electron arrangements.
  - To achieve stability metals may lose electrons and nonmetals may gain electrons producing *ions* which form *ionic bonds*.
    - Group 1 and Group 2 metals lose electrons so that their outside energy level is "complete" or full, forming a stable electron structure like a noble gas. They become positively charged particles (positive ions) because there are fewer electrons (-) than protons (+).
    - Group 16 and Group 17 nonmetals tend to gain electrons so that their outside energy level is "complete" or full, forming a stable electron structure like a noble gas. They become negatively charged particles (negative ions) because there are more electrons (-) than protons (+). Oppositely charged ions attract each other to form ionic bonds.
  - Nonmetal atoms bond with each other by sharing electrons to obtain an electron situation like one of the noble gases and, therefore, become stable. This type of bonding is called *covalent bonding.*

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It is not essential for students to

- Understand hybridization of orbitals or exceptions to the octet rule. At this point students only need to know that atoms achieve stability through bonding to achieve a stable configuration with an electron situation like one of the noble gases (two or eight electrons in the outer energy level).

Assessment Guidelines:

The objective of this indicator is to *explain* the role that bonding has in the achievement of chemical stability, therefore, the primary focus of assessment should be to construct cause and effect models about how elements form bonds to attain stability (an electron situation like one of the noble gases, which have two or eight electrons in the outer energy level).

In addition to *explain*, assessments may require that students

- *Summarize* the major points about elements bonding to achieve stability;
- *Compare* the number of electrons in a stable configuration and a less stable configuration;
- *Infer* whether bonded or unbonded atoms are more stable; or
- *Exemplify* elements that transfer electrons or share electrons.